STATIC STABILITY WIND-TUNNEL TEST OF 18, 22, AND 26 CALIBER CYLINDER-OGIVE BODIES AND AN AEROBALLISTIC TEST VEHICLE AT MACH NUMBERS FROM 0.69 TO 4.24

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28 July 1953

NAVORD REPORT 2934

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U. S. NAVAL ORDNANCE LABORATORY
WHITE OAK, MARYLAND

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STATIC STABILITY WIND-TUNNEL TEST OF 18, 22, AND 26 CALIBER CYLINDER-OGIVE BODIES AND AN AEROBALLISTIC TEST VEHICLE AT MACH NUMBERS FROM 0.69 TO 4.24

Prepared by:

Harvey Chaplin

ABSTRACT: This report presents the results of an investigation in the [illegible] 40 x 40 cm Aeroballistics Tunnel No. 1 to determine the static stability of the Naval Ordnance Test [illegible] Bodies and an Aeroballistic Test Vehicle at [illegible] from 0.69 to 4.24.

U. S. [illegible]

[redacted]

NAVORD Report 2934 — 28 July 1953

This investigation was performed at the request (reference a) of the U. S. Naval Ordnance Test Station. The wind-tunnel data were obtained 21 and 22 May 1953. The investigation was performed under task number NOL-Re3d-453-1-53.

The purpose of this investigation was to determine the static stability of the Naval Ordnance Test Station Long Bodies and and Aeroballistic Test Vehicle.

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[illegible]

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ILLUSTRATIONS

[redacted] Data in Aerodynamic [redacted] Runs 1 through [redacted] Figure 11.

STATIC STABILITY WIND-TUNNEL TEST OF 18, 22, AND 26 CALIBER CYLINDER-OGIVE BODIES AND AN AEROBALLISTIC TEST VEHICLE AT MACH NUMBERS FROM 0.69 TO 4.24

INTRODUCTION

1. The trend of rocket design toward longer bodies has made it necessary to obtain design data on bodies up to 26 calibers in length. In this investigation static stability data were obtained for 18, 22, and 26 caliber bodies as a part of the Naval Ordnance Test Station Systematic Wind-Tunnel Test Program. Data previously obtained under this program for 10, 14, and 18 caliber bodies are reported in references (b) through (g).

2. This report presents pitching moment and normal force data obtained for the Naval Ordnance Test Station Long Bodies at Mach numbers of 0.69, 0.92, 1.56, 1.86, 2.87, and 4.24 and for an Aeroballistic Test Vehicle at Mach numbers of 0.69, 0.92, 1.56, 1.86, and 2.87.

4. All data were obtained using a five-component internal strain-gage balance (designated 5-5) designed and built at the Naval Ordnance Laboratory. The angles of attack include a correction for elastic deflection of the balance.

RESULTS

5. The data are plotted in coefficient form versus angle of attack in Figures 3 through 9. No analysis of these data is being made in this report.

6. Tabulated data of this test are also presented. The sheets of data are in order of run number and have lists of corrected angle of attack, normal force coefficient, and pitching moment coefficient.

REFERENCES

(a) Highberg, Ivar E., NOL Aeroballistic Research Request (ARR 220) (Conf) (1953)

(b) DeMeritte, F. J., Aeroballistic Research Investigation of a Family of Rectangular Finned Models at Mach Number 2.92 NOLM 10117 (Restr) (1949)

(c) DeMeritte, F. J. and Greene, John E., Aeroballistic Research Investigation of Body and Rectangular Fin Combinations at Mach Numbers 1.86 and 1.56 NOLM 10122 (Restr) (1949)

(d) DeMeritte, F. J. and Darling, J. A., Aeroballistic Research Investigation of Body-Along Models at Mach Numbers 1.5 and 2.92 NOLM 10132 (Restr) (1950)

(e) Darling, J. A. and DeMeritte, F. J., Aeroballistic Research Investigation of [redacted] (Conf) (1950)

(f) DeMeritte, F. J., [redacted] E., and Darling, J. [redacted] Report 1874 (Conf)

(g) Darling, J. A., [redacted] Aeroballistic Research Investigation of [redacted] (Restr) (1952)

TABLE I

LIST OF RUNS AND TEST RECORDS CONDITIONS

Run	Configuration	Mach No.	Dynamic Pressure (psi)	Reynolds No. (per ft.)	Figure
1	[illegible]	[illegible]	[illegible]	3.91×10^6	3
2	[illegible]				
3	[illegible]				
4	[illegible]	[illegible]	[illegible]	[illegible]	4
5	[illegible]				
6	[illegible]	[illegible]			
7	[illegible]	[illegible]	[illegible]	[illegible]	6
8	[illegible]				
9	[illegible]				
10	[illegible]				
[illegible]	[illegible]				
[illegible]	[illegible]				
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]				
[illegible]	[illegible]				
[illegible]	[illegible]				
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]		
[illegible]	[illegible]		[illegible]		
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	
[illegible]	[illegible]		[illegible]	[illegible]	
[illegible]	[illegible]		[illegible]	[illegible]	

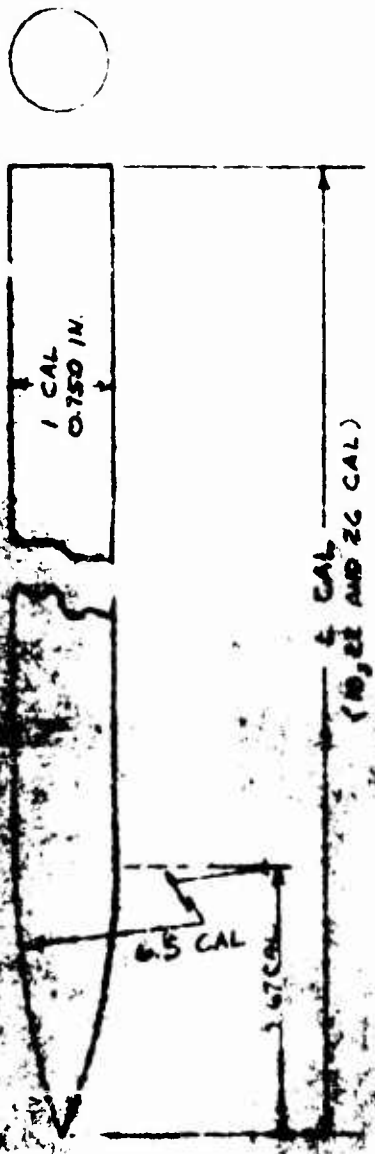
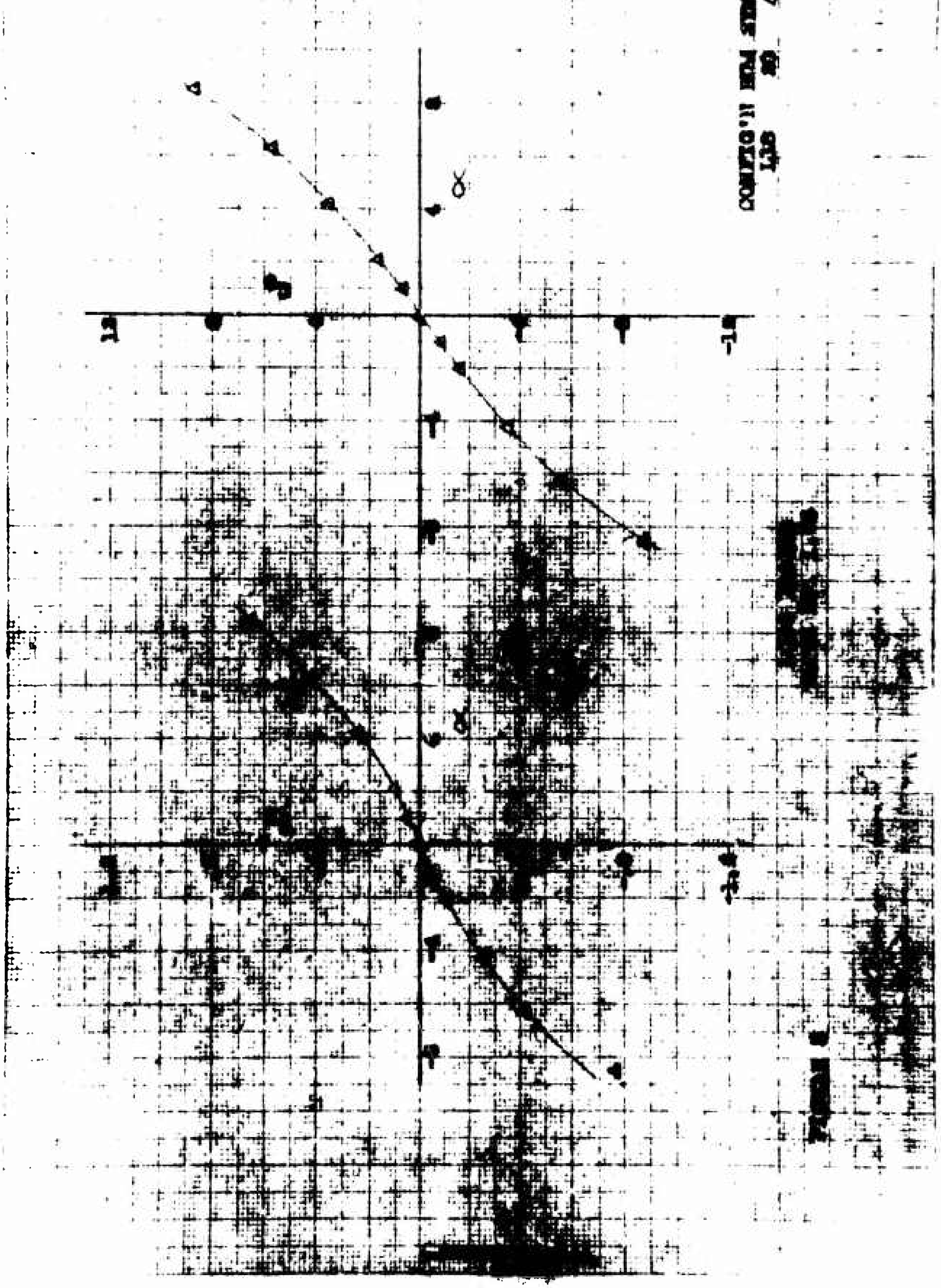
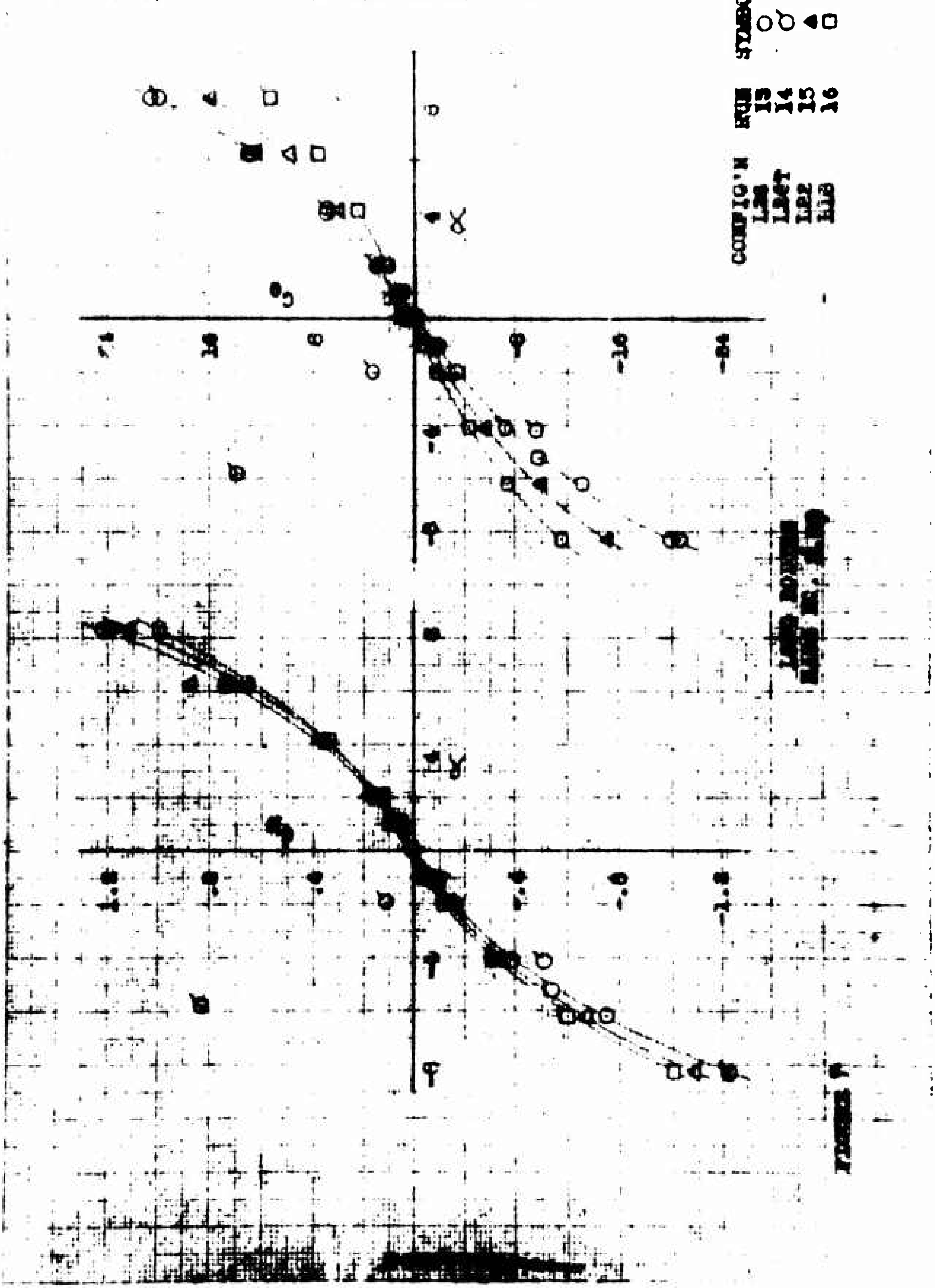


FIGURE 1

NOTS LONG BODIES

FIG. 12 ATV BALLISTIC TEST VEHICLE





SYMBOLS

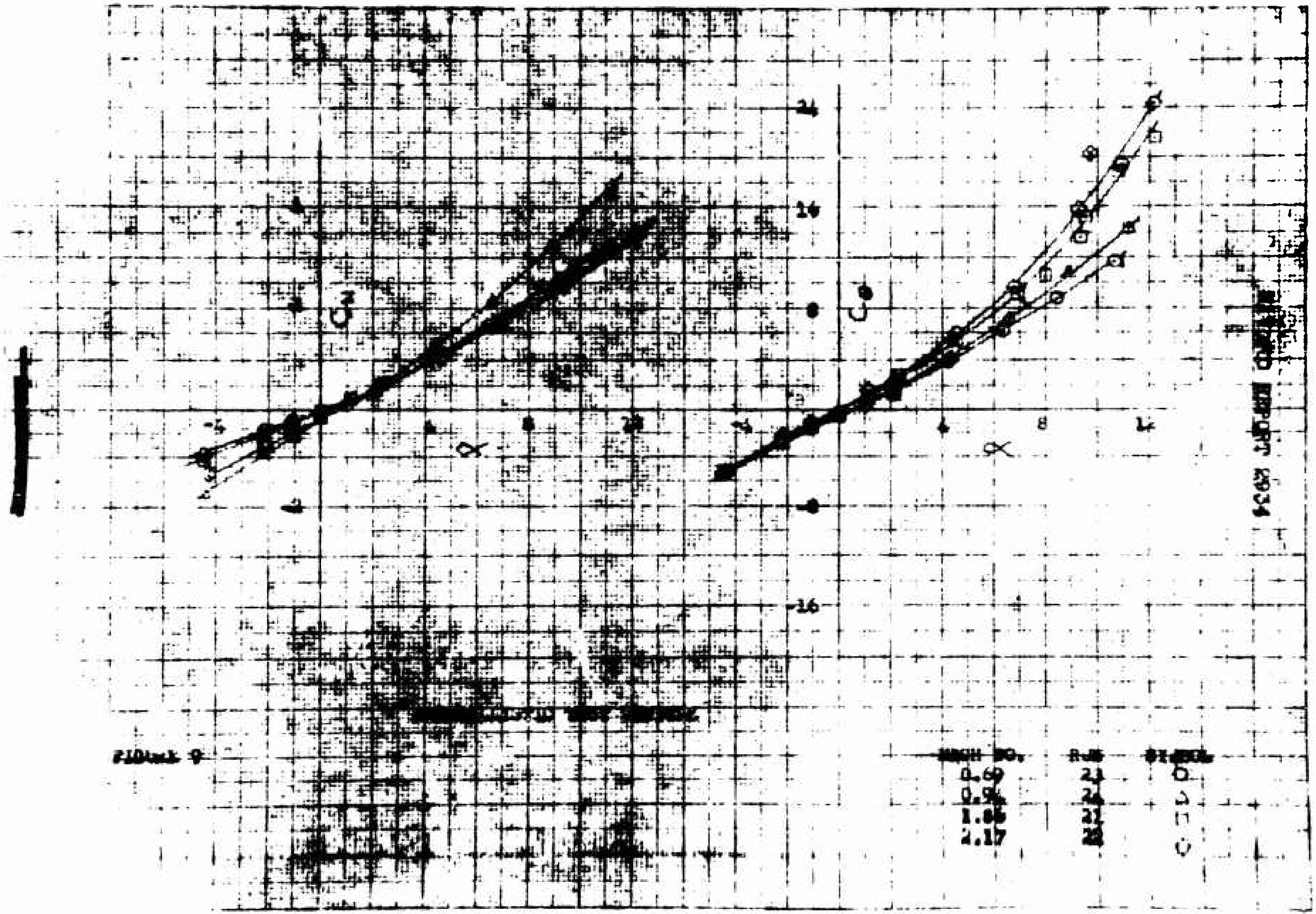
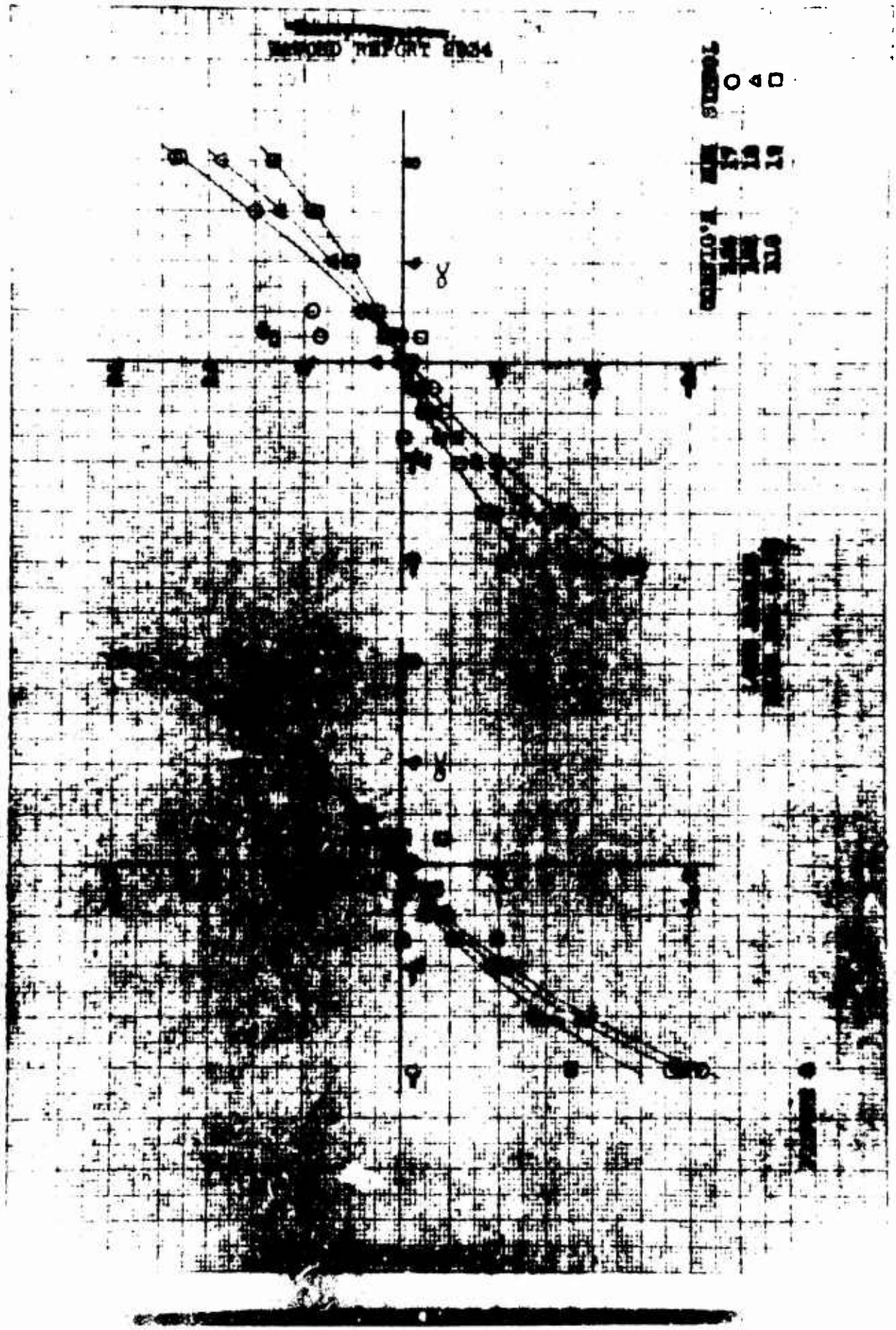


Figure 9



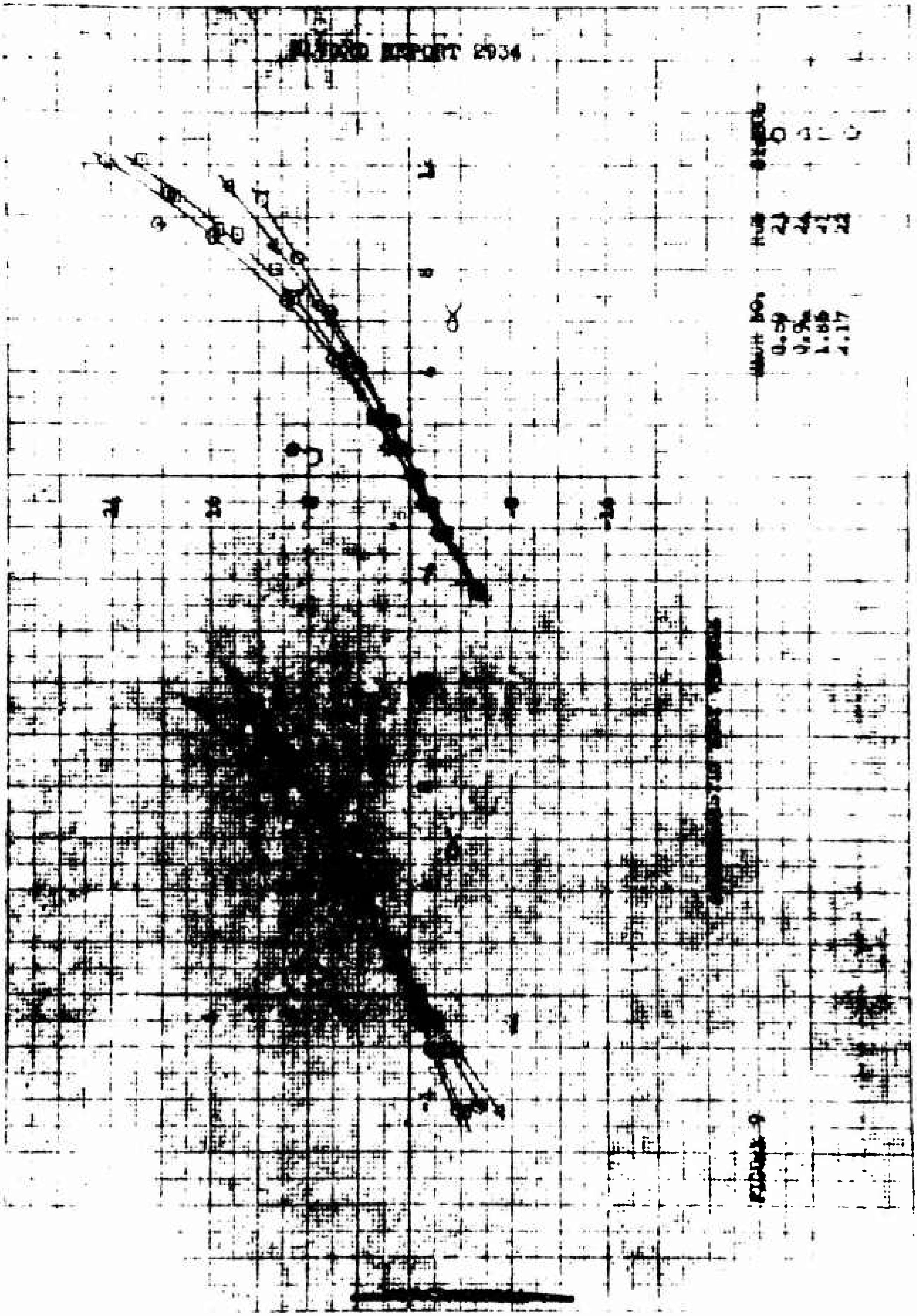


Figure 9

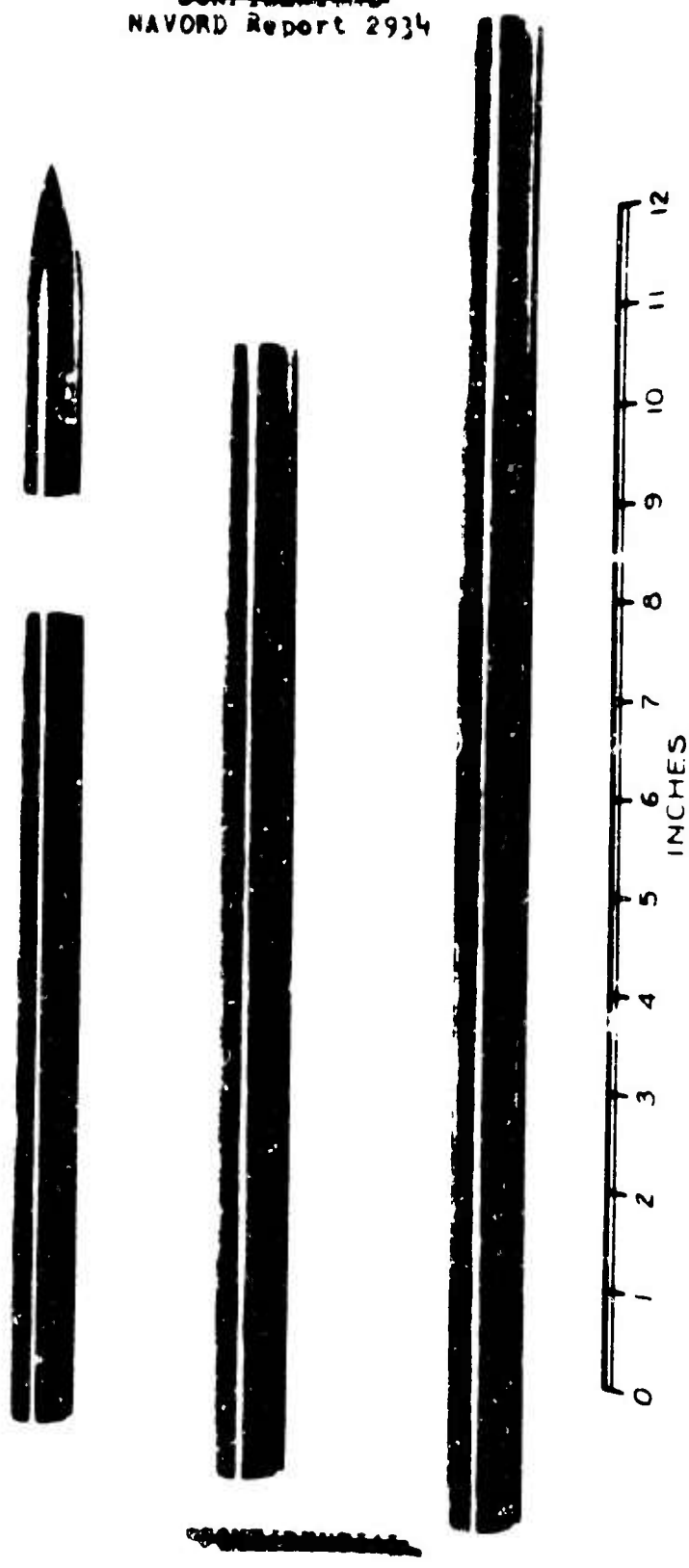


Fig. 10

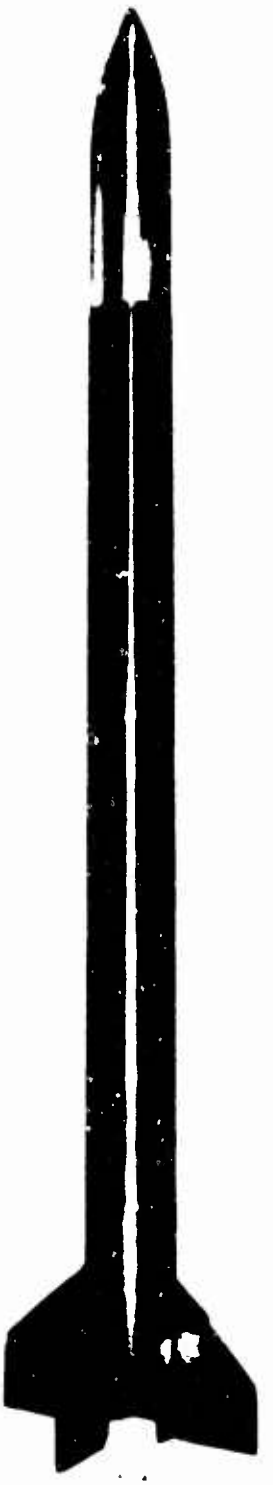


Fig. 11

Tabulated Data Information

A. Column Heading symbols are defined on page 1.
B. Decimal points for the coefficients and angles occur as indicated on Run 1.
C. The sign of the coefficient and angles follow the readings.

[redacted]

P24 01

Cl

6 15-
4 11-
2 06-
1 04-
02-
0[illegible]
2 04
4 07
6 12
8 1H
2 06-
2 03
1 03-
08-
1 01
1 03-

Cr

544H-
3565-
1747-
1387-
0545-
0219-
0H70
2142
3708
5491
1714-
0804
0H74-
0712-
0147
0972-

Ce

9 2757-
6 1661-
3 1100-
2 3674-
9347-
1652-
1 7402
2 2093
6 6958
9 7071
3 1131-
1 6P69
1 5729-
1 1224-
3505
1 7907-

[redacted]

[redacted]

2 < R	0 3						
		5	17-	4 7 7 H-		6	9 4 3 0-
		4	11-	3 [illegible] 8 5-		4	5 5 [illegible] 4-
		2	06-	1 H 4 0-		2	6 [illegible] 3 8-
		1	04-	1 1 9 9-		1	7 [illegible] 5 7-
			01-	U 5 2 8-			6 [illegible] 4 3-
		1	01	U [illegible] 3 6-			1 1 4 5
		2	03	U 6 7 7		1	2 1 2 2
		4	08	1 H 2 3		3	0 5 4 7
		6	13	3 2 0 9		5	1 2 1 9
		8	20	5 2 0 7		7	0 0 9 7
		6	17-	4 6 6 [illegible] -		[illegible]	8 4 5 2-
		2	06-	1 H 3 2-		[illegible]	6 2 0 9-
		1	04-	1 [illegible] 8 5-		1	5 1 5 9-
		1	00	U 1 6 9-			0 1 1 0
		1	04-	1 2 2 5-		1	6 0 3 3-

[redacted]

228 03

α	C_N	C_o
6 18-	4296-	5 1966-
4 12-	2627-	3 4054-
2 06-	1309-	1 6278-
1 04-	1157-	1 2974-
02-	0424-	5510-
1 00	0118-	0701
2 03	0355	7213
4 08	1624	3068
6 14	2819	5 8048
8 20	4569	5 8180
2 07-	1590-	1 9290-
1 04-	1117-	1 8535-
1 01	0003-	1579
6 18-	4387-	5 2616-

[redacted]			
228 04	α	C_N	C_θ
	6 23-	5682-	9 5167-
	4 15-	3469-	5 9311-
	2 08-	2038-	3 4036-
	1 05-	1172-	1 9926-
	00-	0407-	6463-
	1 01	0044	2211
	2 04	0738	1 4646
	4 11	2247	4 0340
	6 19	4154	7 3354
	8 27	6591	11 1490
	02-	0640-	1 0109-
	1 05-	1219-	2 0387-
	1 61	0165	4092
	8 27	6487	10 9616
	8 27	6364	10 8319

[redacted]

[redacted]			
228 05			
	6 25-	5409-	7 5001-
	4 14-	3 54-	4 5812-
	2 08-	1771-	2 4901-
	1 05-	1220-	1 5864-
	02-	0551-	5736-
	1 05	0773	1 2714
	2 09	0564	1 1055
	4 12	2483	3 2477
	6 20	3680	5 5621
	8 30	5201	8 5188
	1 05-	1103-	1 4354-
	1 01	0201	2054
	2 05	0783	1 3337
	6 25-	5214-	7 2773-

[illegible]
22A 06

	α		C_N		C_m
6	27-		4753-	5	4922-
4	18-		3141-	3	6451-
2	09-		1524-	1	7799-
1	05-		0912-	1	0794-
	01-		0302-		2769-
1	02		0100		3168
2	04		0258		7124
4	13		1910	2	5840
6	21		3265	4	2817
8	31		5129	6	2175
1	05-		0884-	1	0061-
1	01		0072		2605
2	06		0776	1	1142
8	40		6761	8	1964

[redacted] 220 07	α	C_N	C_ℓ
	8 45-	7565-	14 3079-
	6 32-	5525-	10 8256-
	4 21-	3404-	6 5723-
	2 11-	1407-	3 1751-
	1 07-	0869-	1 5990-
	01-	0118-	2281-
	1 05	0610	1 3159
	2 09	1164	2 5334
	4 19	2950	5 7909
	6 33	5110	10 0456
	8 51	8874	16 4721
	6 36-	5559-	10 8784-
	1 07-	0708-	1 7175-
	8 56-	1 0766-	18 4319-
	4 21-	3308-	6 4582-
	4 20	3023	5 9594

[redacted]

[redacted]

22A 06	α	C_N	C_o
	8 49-	0052-	16 3943-
	6 34-	5567-	10 4263-
	4 21-	3418-	6 5509-
	2 12-	1713-	3 4581-
	1 07-	0839-	1 8379-
	01-	0107-	2400-
	1 05	0604	1 3583
	2 10	1277	2 7417
	4 19	2286	5 8259
	6 31	4828	9 5138
	8 47	8145	15 0980
	8 40-	7290-	13 2396-
	1 07-	0866-	1 8766-

[redacted]

RUN
228 04

	α	CN	Cθ
	8 59-	9554-	14 5137-
	6 37	5369-	8 7175-
	4 22	3205-	5 2008-
	2 11	1638-	2 6890-
	1 06	0940-	1 4979-
	00	0203-	1634-
	1 05	0432	1 0581
	2 10	1069	2 1531
	4 20	2554	4 8498
	6 35	4641	7 9532
	8 55	8509	13 3003
	8 55	8425	13 2817
	5 28-	3967-	6 6106-
	1 06-	0903-	1 4840-

RUN 22A 10	α	C_N	C_ℓ
	8 47-	7313-	11 3673-
	6 35-	5037-	8 2219-
	4 21-	3161-	5 0624-
	2 11-	1576-	2 5854-
	06-	0955-	1 4921-
	00	0167-	0 5284-
	06	0530	1 1978
	11	1151	2 2910
	20	2569	4 5866
	34	4700	7 9729
	8 52	8167	12 7018
	8 47-	7535-	11 6084-
	6 40-	6079-	9 5842-
	1 11-	1844-	2 7354-
	4 35-	5005-	8 1962-

RUN	α	C_N	C_θ
228 11	8 66-	9585-	11 7178-
	6 37-	4776-	6 5309-
	4 22-	2740-	3 [redacted]
	2 11-	1347-	1 [redacted]
	1 06-	0748-	1 [redacted]
	00	0078-	0 [redacted]
	1 06	0589	9 [redacted]
	2 11	1158	1 [redacted]
	4 22	2495	3 [redacted]
	6 37	4476	6 [redacted]
	8 56	6050	10 [redacted]
	1 06-	0728-	1 [redacted]
	6 36	4399	6 [redacted]

RUN	α	C_N	C_m
22R 12			
	36-	4464-	6 2[illegible]R-
	25-	3361-	4 4 0[illegible]-
	11-	139R-	1 9679-
	06-	0R24-	1 1012-
	00	0037-	0459
1	06	0580	1 0339
3	11	1220	1 9656
1	22	2604	3 8405
6	35	4174	6 0964
8	54	7313	9 5580
8	55-	7473-	9 6791-
4	22-	2756-	3 8231-
1	06-	0R10-	1 06[illegible]-
1	06	0616	1 0[illegible]
8	53	7133	9 4[illegible]

[redacted]		α	C_N	$C_\bullet$
228	13			
		6 20-	7521-	13 1[redacted]-
		4 12-	3850-	7 3[redacted]-
		2 06-	1652-	3 3[redacted]-
		1 03-	0796-	1 6[redacted]-
		0 00	0014	0 2[redacted]-
		1 03	0760	1 3[redacted]
		2 06	1545	3 1491
		6 20	7396	12 9[redacted]
		8 29	1 2237	20 4[redacted]
		8 29-	1 2327-	20 5[redacted]-
		5 16-	2431-	9 3[redacted]-
		1 03-	0860-	1 7[redacted]-
		1 03	0612	1 3[redacted]
		4 12	3612	6 9[redacted]

[redacted]

RUN
828 14

	α		C_N		C_θ
8	28-	1	2058-	20	0555-
5	80-		8270	13	9358
4	16-		5149-	9	5996-
1	94-		1616	3	3052
1	03-		0756-	1	5594-
	00		0044		0856
1	03		0711	1	5286
2	05		1492	3	0119
4	12		3661	7	0054
6	19		7359	12	8511
8	28	1	1836	19	7516
4	12-		3798-	7	2406-

[redacted]

220 15

α	C_N	C_θ
8 31-	1 0834-	15 2045-
6 21-	6753-	9 9550-
4 13-	3385-	5 5811-
2 06-	1391-	2 4508-
1 03-	0728-	1 2287-
1 03	0573	1 1917
2 07	1793	2 3494
4 13	3774	6 0089
6 86	8760	12 6454
8 32	1 1230	15 7796
00	0144	1701
1 03-	0693-	1 1911-
6 21	6725	9 9248
1 03	0622	1 2209
2 06	1230	3 3479

[redacted]

[illegible]
220 16

	α
8	33-
6	22-
4	13-
2	06-
1	03-
	00
1	04
2	07
4	13
6	22
8	33
6	22
1	03-
1	03
2	06
1	03

	C.V
1	0028-
	6134-
	3215-
	1861-
	0450-
	0021-
	0916
	1422
	3365
	6633
	9852
	6305
	0667-
	0633
	1464
	0665

	Co
11	6867-
7	4247-
4	3411-
1	9497-
	0416-
	0611-
1	1045
2	1367
4	4786
7	6018
11	3133
7	5562
	9952-
	9731
2	1156
1	1646

[illegible]
228 17

J.		CN		Co	
8	08-	1	1837-	18	8076-
6	06-		7863-	13	3809-
4	04-		4306-	7	7[illegible]-
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[illegible]	01-		0738-	1	5343-
	00		0845-		5649-
1	[illegible]		3822	6	6[illegible]
2	03		4062	7	8046
6	05		7100	11	9704
8	06	1	1842	18	0703
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	01-		0475-		[illegible]-
1	00		0317		7[illegible]
2	02		1737	3	[illegible]
8	08-	1	2465-	19	[illegible]-
8	08-	1	2138-	19	3[illegible]-
6	06-		8423-	14	1[illegible]-
8	07	1	1513	18	3[illegible]

[redacted]

	X	CN	C●
228 16			
	8 10-	1 1572-	15 7814-
	6 06-	7168-	10 2757-
	4 04-	3992-	6 0437-
	2 02-	1574-	3 [illegible]
	1 01-	0320-	[illegible]
	00	0279	[illegible]
	1 01	0399	[illegible]
	2 02	1574	[illegible]
	4 04	3553	[illegible]
	6 06	7048	[illegible]
	8 09	1 1049	[illegible]
	4 01-	0711-	[illegible]
	1 01-	0884-	[illegible]
	01	1777	[illegible]
	1 01	0456	[illegible]
	2 02	1559	[illegible]

[redacted]		α		CN		Co	
228	19						
		3	08-	7095-		8	3703-
		6	07-	6508-		7	6133-
		4	04-	3737-		4	6734-
		2	02-	1006-		1	6736-
		1	01-	1511-		1	6671-
			00	0136			0242
		1	01	0567			6035
		2	02	1375		1	6[illegible]
		4	04	3517		4	3[illegible]
		6	06	5754		6	8[illegible]
		8	09	9562		10	5[illegible]
		6	06-	5583-		6	6[illegible]
		2	02-	1796-		2	8[illegible]
		1	01-	0639-			[illegible]
			00	0482-			[illegible]
		1	01	[illegible]847		1	4[illegible]
			00	0818-			4[illegible]
			99	1610-		1	4[illegible]
		1	00	0078-			[illegible]
		4	04	3850		4	1[illegible]
		6	06	6131		7	1[illegible]
		5	04-	3959-		4	5[illegible]
		4	04-	3619-		4	6[illegible]
		3	03-	2342-		2	9[illegible]
		3	03-	2892-		2	9[illegible]
		3	00-	0136-		1	1[illegible]

[redacted]

[redacted] &C

8	53-	7656-	[redacted]
6	36-	4200-	5 7705-
4	23-	2616-	3 [redacted]
2	11-	1176-	1 [redacted]
1	06-	0616-	[redacted]
	01-	0043-	[redacted]
2	10	1094	1 [redacted]
6	36	4147	5 [redacted]
8	54	6525	6 [redacted]
1	06-	0602-	[redacted]
	01-	0048-	[redacted]
1	05	0509	[redacted]
4	22	2516	3 [redacted]

[redacted]

[redacted] 228 21	α	CN	Co
	4 51 -	1 4567 -	3 4[redacted]
	2 23 -	6889 -	3 [redacted]
	1 14 -	3738 -	2 [redacted]
	01 -	0134 -	[redacted]
	1 10	3343	1 [redacted]
	2 26	7490	4 [redacted]
	4 52	1 4940	[redacted]
	6 [redacted]	3826	14 [redacted]
	9 68	4 0517	27 [redacted]
	12 17	4 7713	3 [redacted]
	4 52 -	1 4666 -	[redacted]
	2 25 -	7161 -	[redacted]
	1 13 -	3556 -	[redacted]
	01 -	0130 -	[redacted]
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[illegible]
228 82

α		CN		C[illegible]	
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2	18-		5864-	3	4989-
1	10-		2960-	1	8477-
	01-		0255-		8678-
1	13		2723	8	4089
2	21		6467	3	9078
4	48	1	4893	9	1573
6	92	2	2029	15	3[illegible]
9	71	4	2260	32	0[illegible]
12	07	4	7318	38	5[illegible]
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	04		0988		74[illegible]
	90		3109-	1	91[illegible]-
	88-		3688	[illegible]	3[illegible]
4	43	1	3008	[illegible]	2[illegible]
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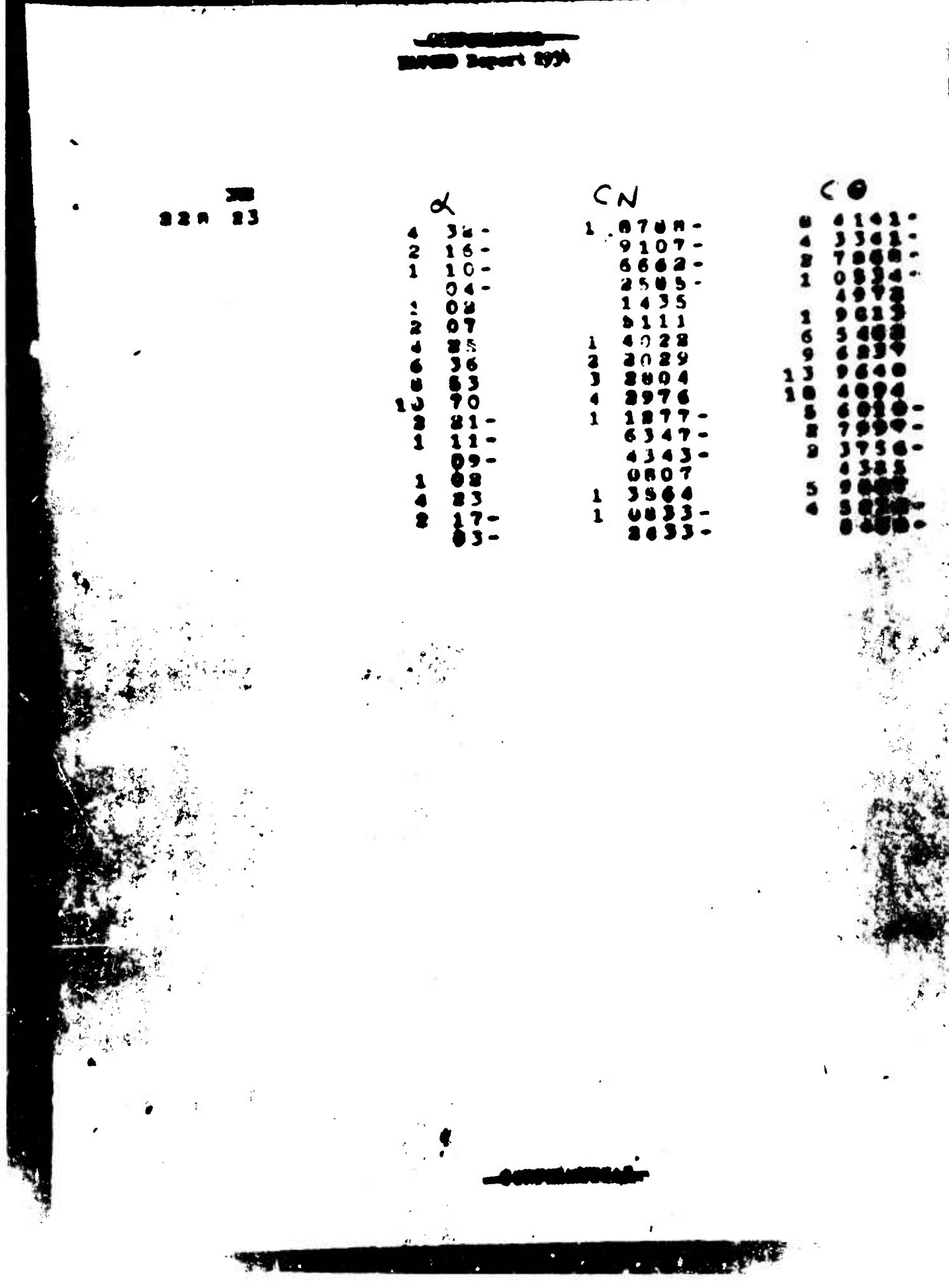

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228 24

α		C_N		$C_θ$	
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2	15		7850	8	7853
4	36	1	7349	6	6588
6	61	2	8906	11	3886
9	91	4	4238	17	1094
11	20	5	7429	22	4849
6	61	2	9296	11	6943
8	93	4	4705	17	3748
11	31	6	0036	24	3773